Semiconductors - The Crude Oil of the Telecommunications Revolution

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AMD at a Glance

- Fourth Largest US Semiconductor Company
  - sales 2.4 Billion Dollars
  - Second largest supplier of 32 bit microprocessors
  - 40% of AMD business - communications
  - Number one LAN IC supplier 1995*
  - Largest Line card circuit producer** 150 million shipped to 70 countries
  - CT2 cordless, 802.11 wireless LAN, ISDN, FDDI

* per Dataquest, 1995
** Non-captive

PCs and Communications

- Microprocessors Today - 10 Million transistors
  - Allow communications problems to be solved in unique ways
  - PC technology will drive advanced communications
  - “Crude Oil” that will enable the communications revolution

Goals for Today

- Use AMD's cross-industry knowledge of PCs and communications to provide:
  - Historical perspective of advanced technologies
  - Current perspective on emerging technologies and opportunities
  - Scenarios for success

Semi- History

- 1984 - ISDN Debuts
- Promises high bandwidth, improved voice quality, advanced services
- 1995 Installed base (US) 400k units
- Technical Issues
  - SS#7 and islands
  - Incompatible Layer 3 signaling software
  - Poor user demand and little application support
  - Clear channel 64k B channels via IXC
  - Difficult to configure - RBOC and user

Semi-History

- FDDI
  - promised 100 Mbps
  - fault tolerant
  - Fiber based for improved BER
  - remains a distant second to Ethernet in installed nodes
- Token Ring 4/16
- Video-on-Demand
- Name your poison

What did we learn?

- Incumbent technology difficult to replace
- Forecast accuracy is questionable - get closer to end-user
- Guaranteed Rate of return thwarted semiconductor and equipment development
- Standards are necessary evil
- Risk / reward sharing encourages efficient development of solutions

Opportunities

- Unbundled Local Loop
- Cable Modems
- Wide Area Bandwidth Exploitation
- Wireless
- ATM

Local Loop Unbundling

- Provides competitive service providers the toehold they need
- Target Markets
  - Telecommuting
  - Internet Access
  - Remote LAN access
- Incumbent LECs have heretofore focused on video delivery via copper.
  - High cost points
  - Condition of copper plant is an issue

Unbundling

- Estimates as high as 600 Billion Dollars undepreciated copper in US local loop
- VOD trials and Deathstar have slowed interest in video service
- OVP levels playing field
- Savvy players looking at ADSL derivatives
  - Levers the technology but at a different data rate / price point
  - Supports consistent wide area strategy

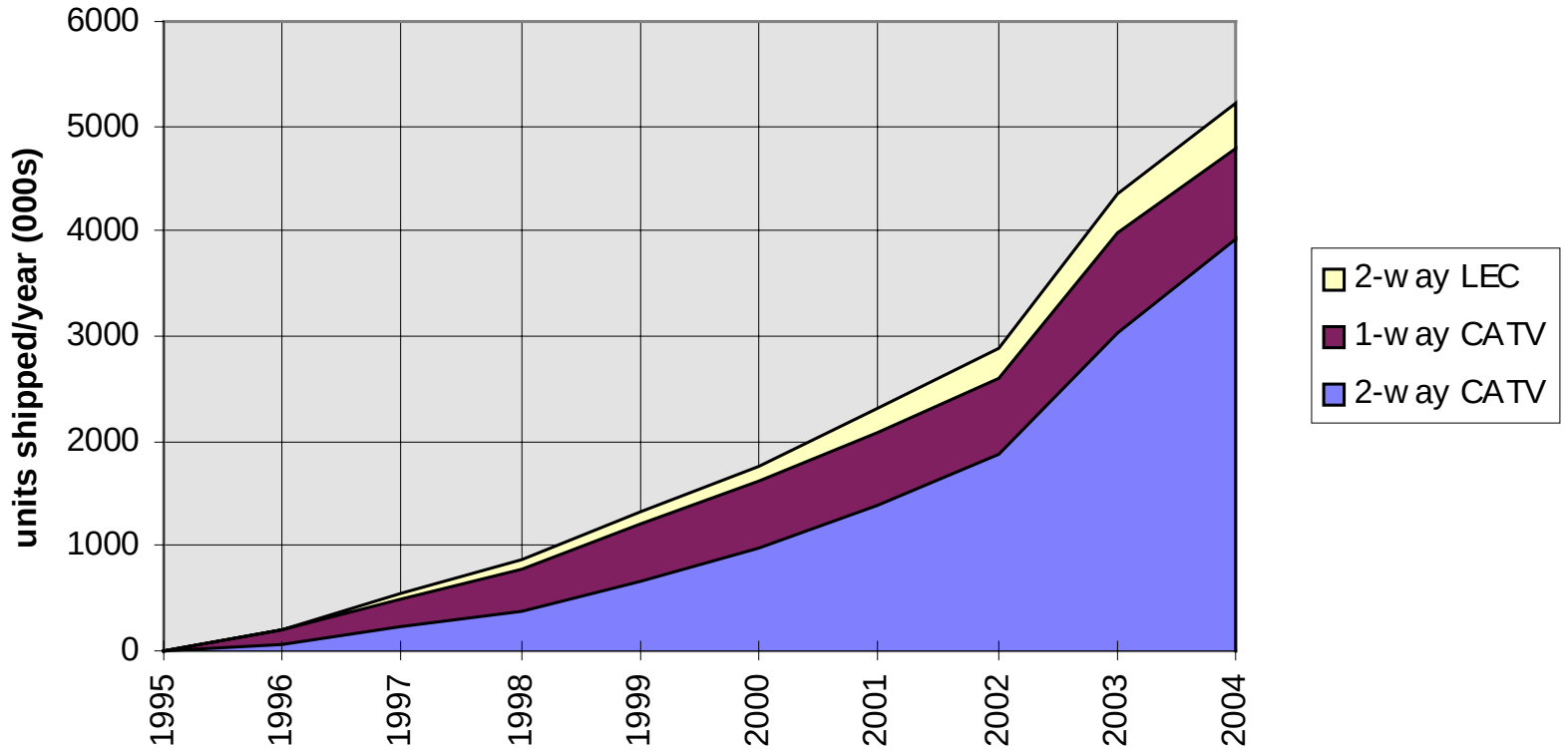
ADSL- Lite (TM)

- AMD is evaluating light version of ADSL
  - DMT or CAP16 based 384kbps full duplex
  - Low cost points
  - Operates over extended distances
  - Useful for access in noisy reverse channel in cable modem applications, Home area nets

Cable Modems

- In theory:
  - uses modified cable infrastructure to deliver 1-4 Mbps per 6 MHz. channel downstream bandwidth shared among clusters of 500 homes.
  - Reverse Channel bandwidth varies from 384kbps to 1 Mbps
- In reality
  - current installed equipment is not suitable
  - infrastructure upgrades are expensive $500-$1500 per subscriber
  - MSOs are in need of cash (S.652 will help)
  - volumes expected to be near 3M units by 2000

Cable Modem Market Update



Source: Probe Research (preliminary)

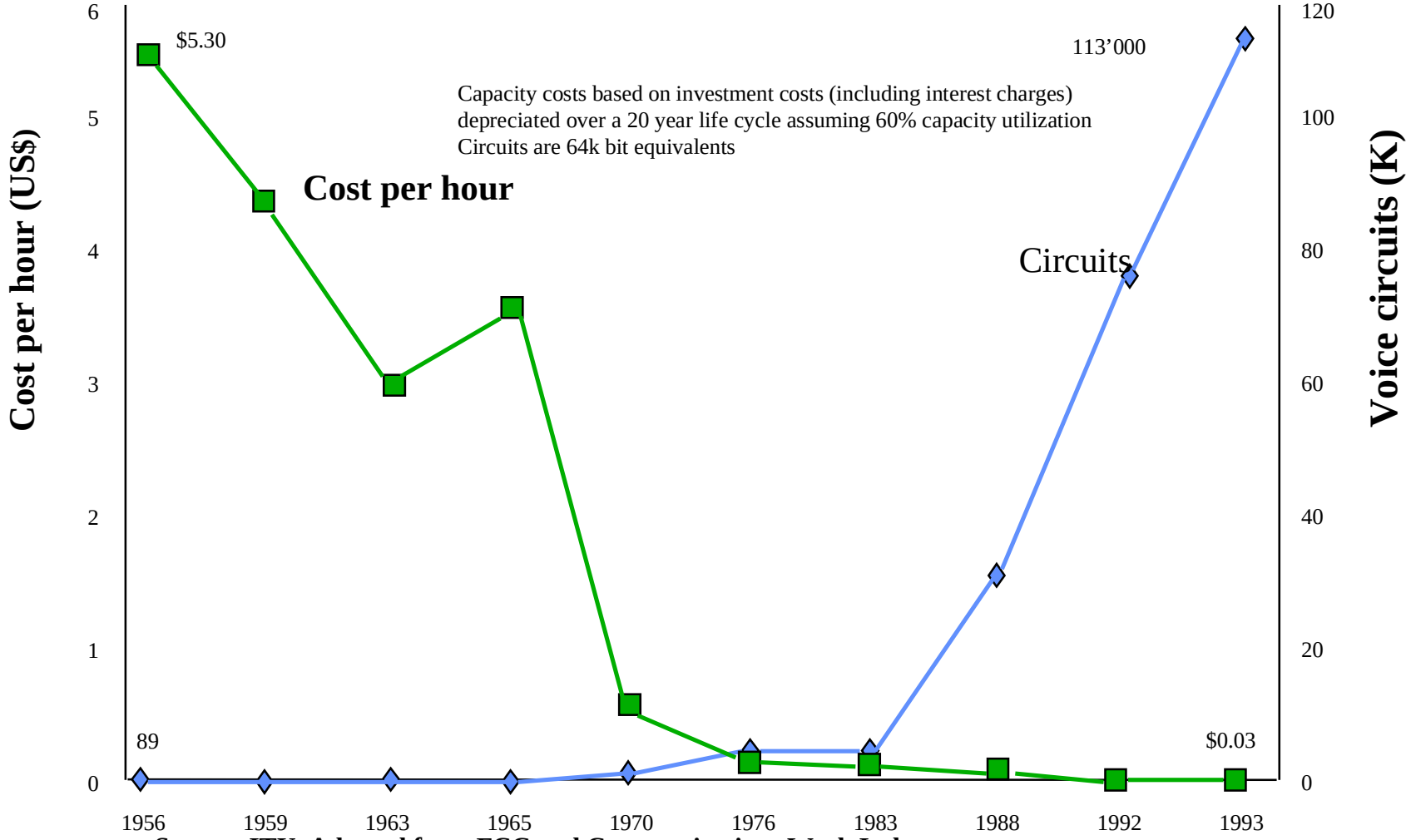
Cable Modems

- AMD invests in core technology
  - supports advanced services in cable environment
  - joint investment with equipment manufacturer and networking partner

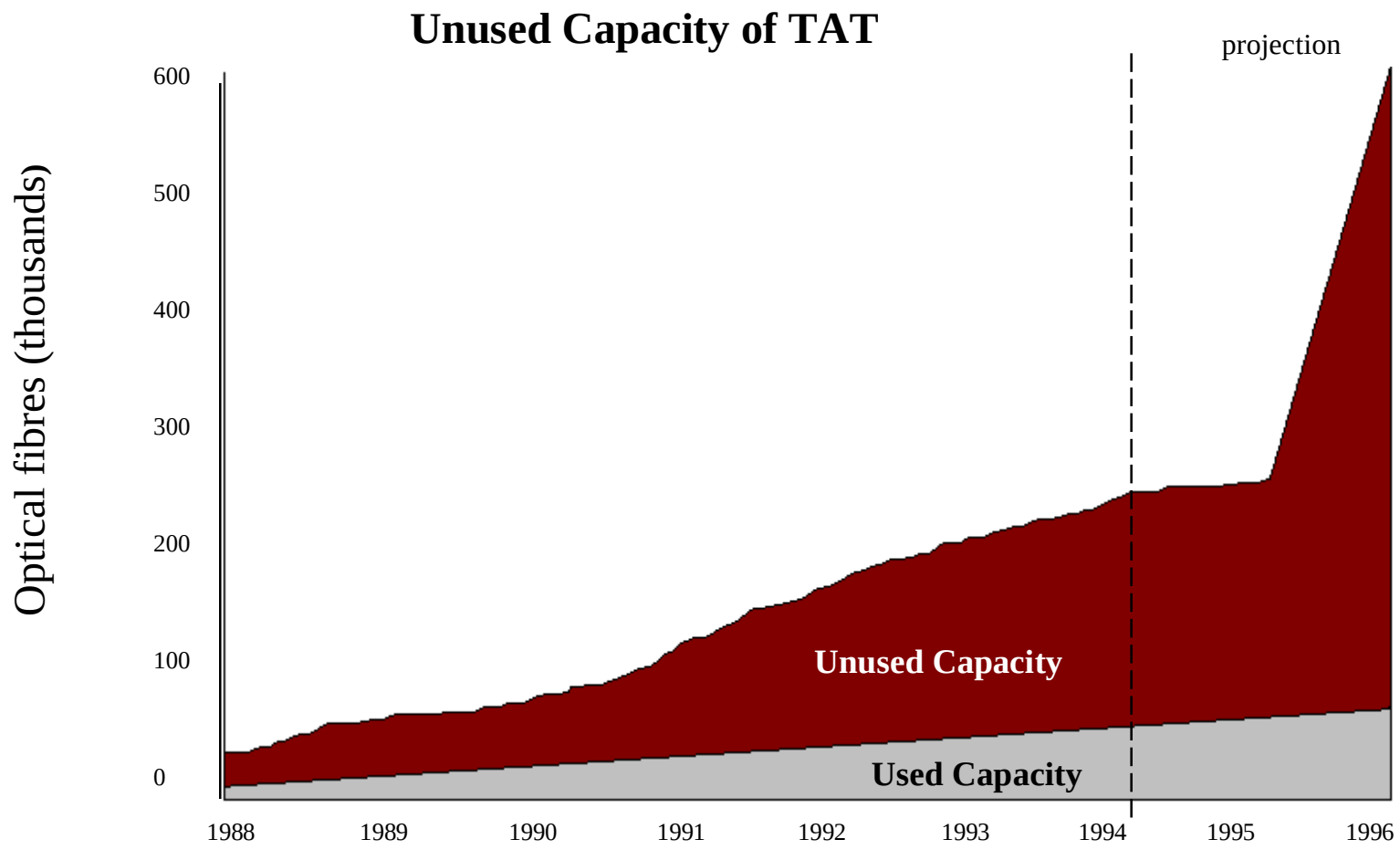
Exploit the bandwidth

- Internet has destroyed concept of “distance based billing”
  - EMAILS, voice mails, and voice calls actually travel via TCP/IP today
- Will new entrants enable wide area connectivity via reduced price points?
- Wide area bandwidth increases drive the ‘last mile’ technologies -- AMD invests here

Capacity Cost and Growth, TAT Cables



Source: ITU, Adapted from FCC and Communications Week Intl.



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Wireless

- PCS auction ‘winners’ scramble
- Too many providers chasing too few customers
- Incumbents (cellular) will be tough to dislodge
  - marketing
  - existing customers
  - economies of scale in handset manufacturing
- Advanced Technologies have failed to deliver and have fragmented development efforts
  - economies of scale suffer with fragmentation
  - market instability delays development

ATM- Another Technical Morass?

- Introduced with much fanfare - similar to ISDN
- “Last Networking Technology”
- Flexible
  - supports voice, data, video
  - scaleable
  - compatible with SONET
- Complexity is high
- Interoperability remains an issue
  - signaling
  - congestion control

ATM@AMD

- Invested in switching technology
  - IP allows scalability with constant cost/port
  - No products announced - awaiting volume
- Switching in the PC
  - Route Streams of data to appropriate subsystems
  - Avoid burdening processor with data sources that do not need or require overhead of protocol stacks
  - Truest form of convergence - Communications circuitry embedded on the processor's bus

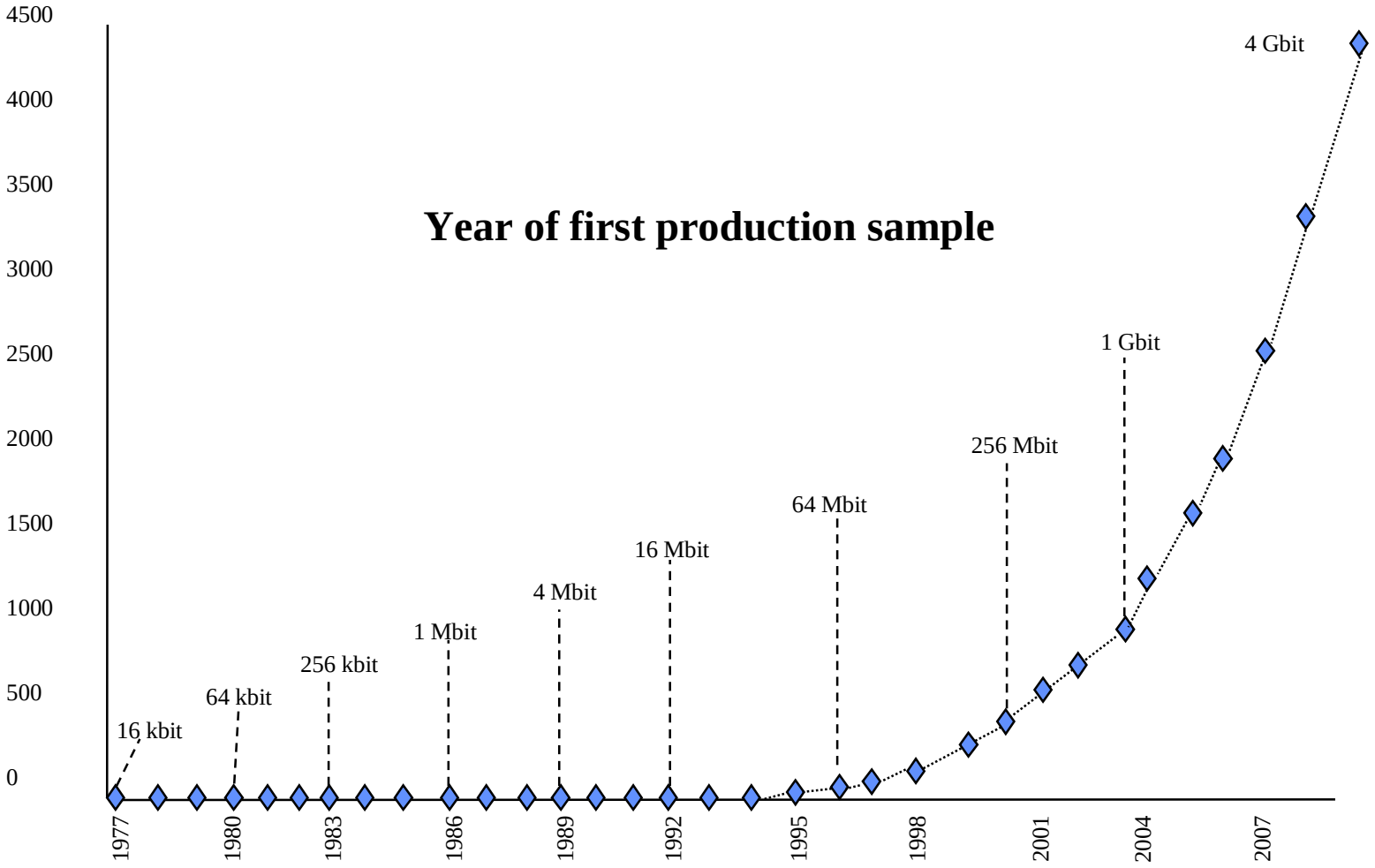
Likely Scenarios

- Pipe to the home fattens
- Wireless Grows - both cellular and FRA technologies
- PCS entrants scramble
- Deregulation fuels ROI erosion in verticals and drives tightening in cost structures of service providers and equipment manufacturers

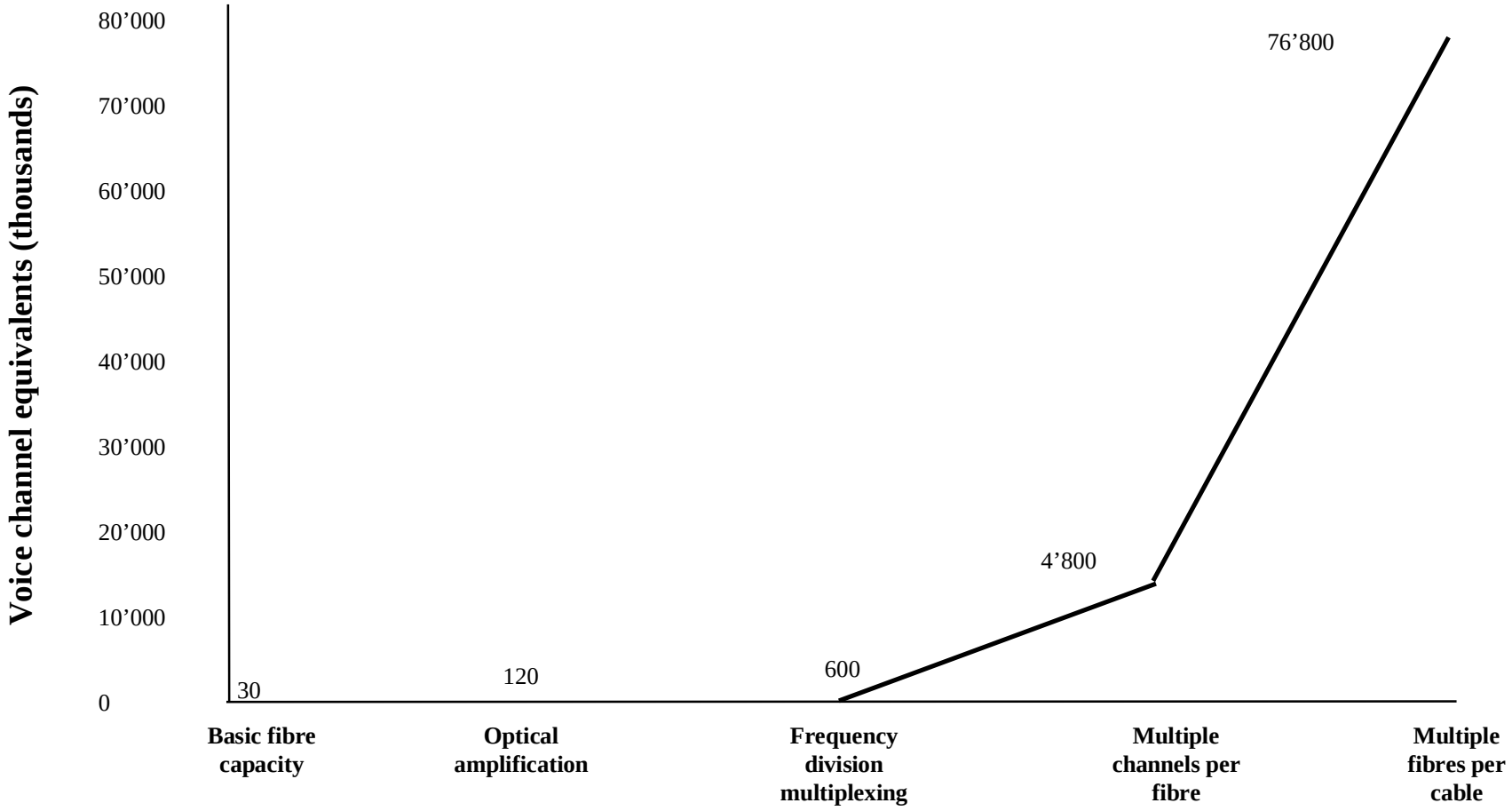
Likely Scenarios

- Distance based billing begins to change
- Old technology hangs on longer than anticipated
- Opportunities exist for strange bedfellows

Mbit of storage capacity



Voice Capacity as a function of Technology



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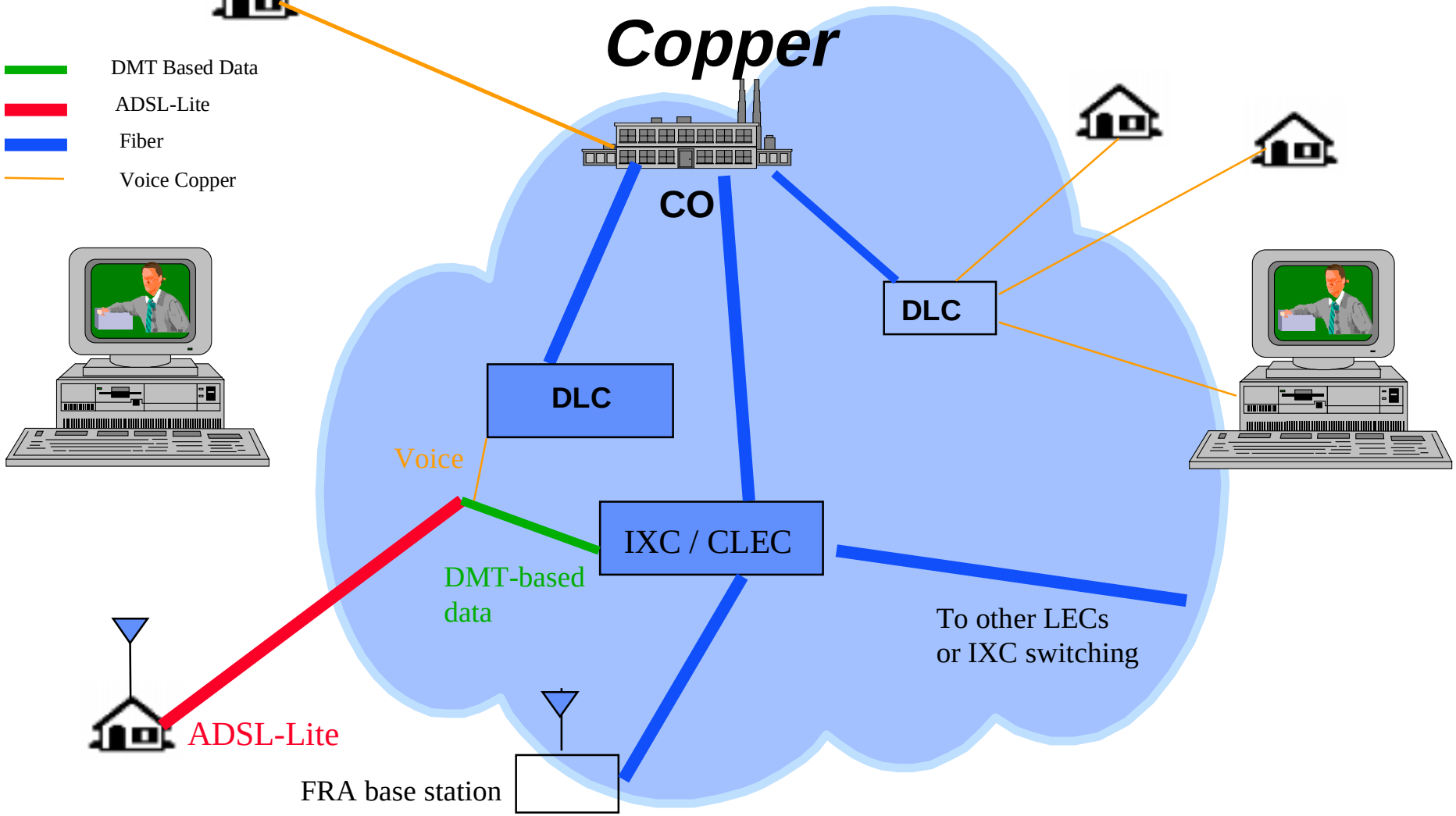
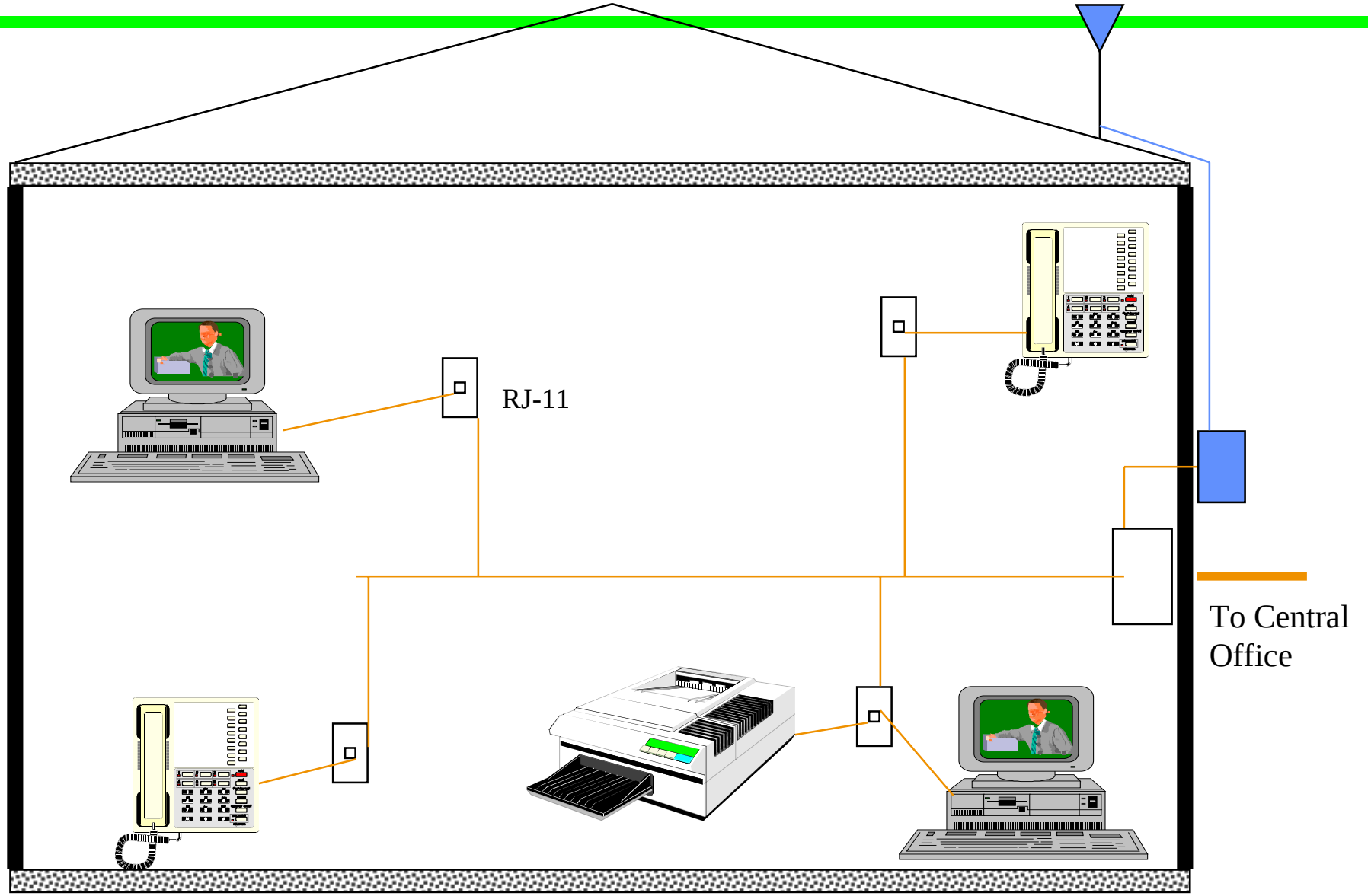
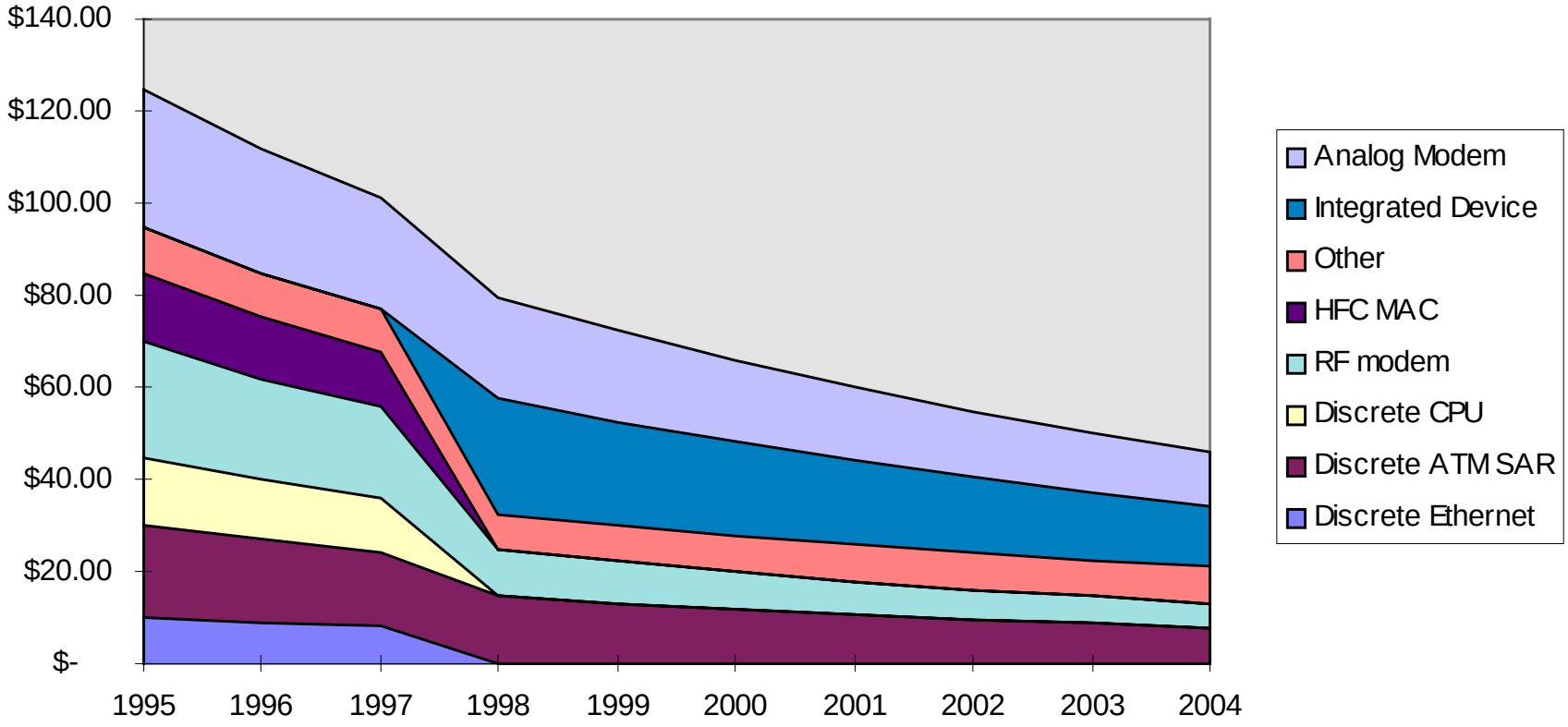
Communication and Computation



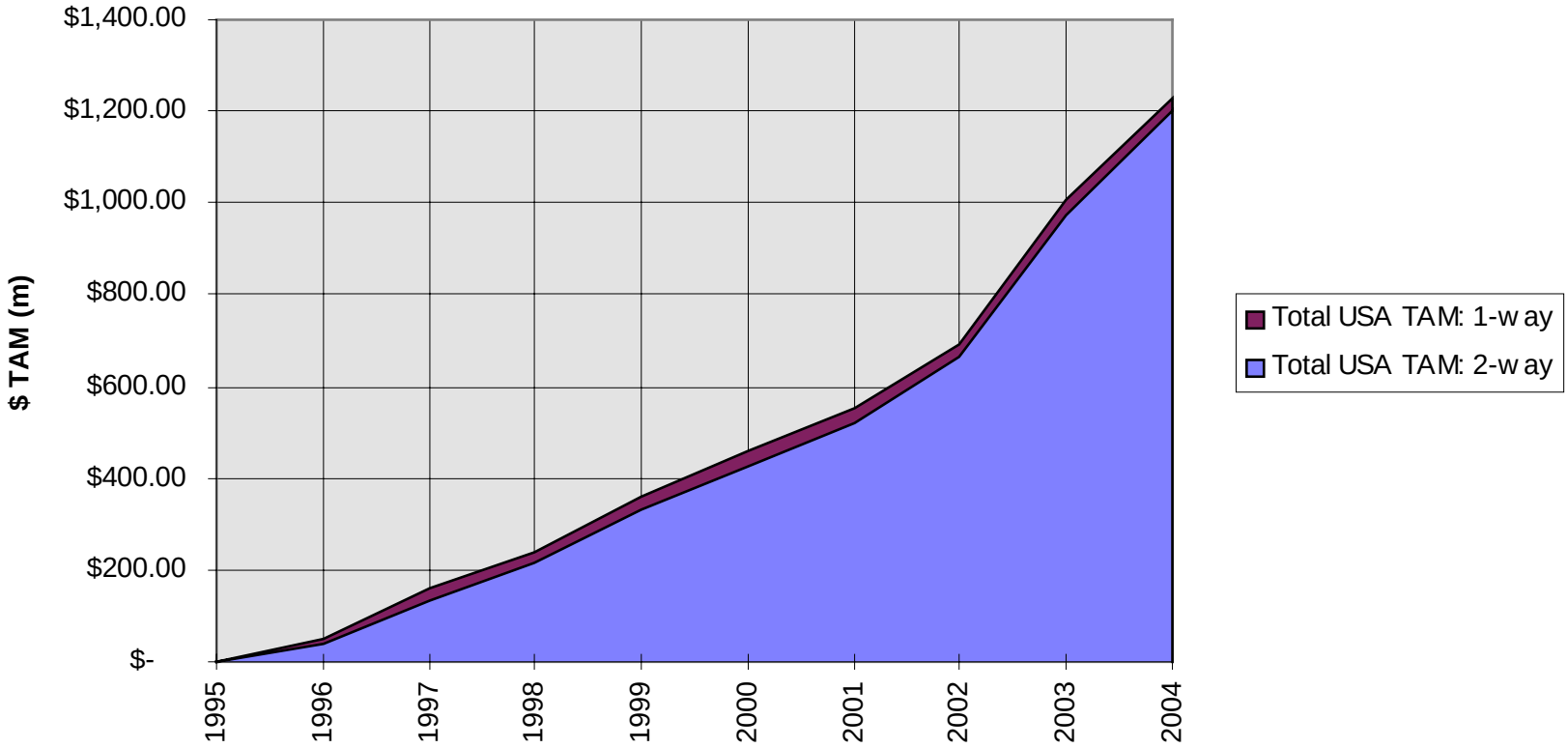

RJ-11
To Central Office

Crude Silicon Breakdown



Source: AM, Probe Research (preliminary)

Cable Modem Si Opportunities



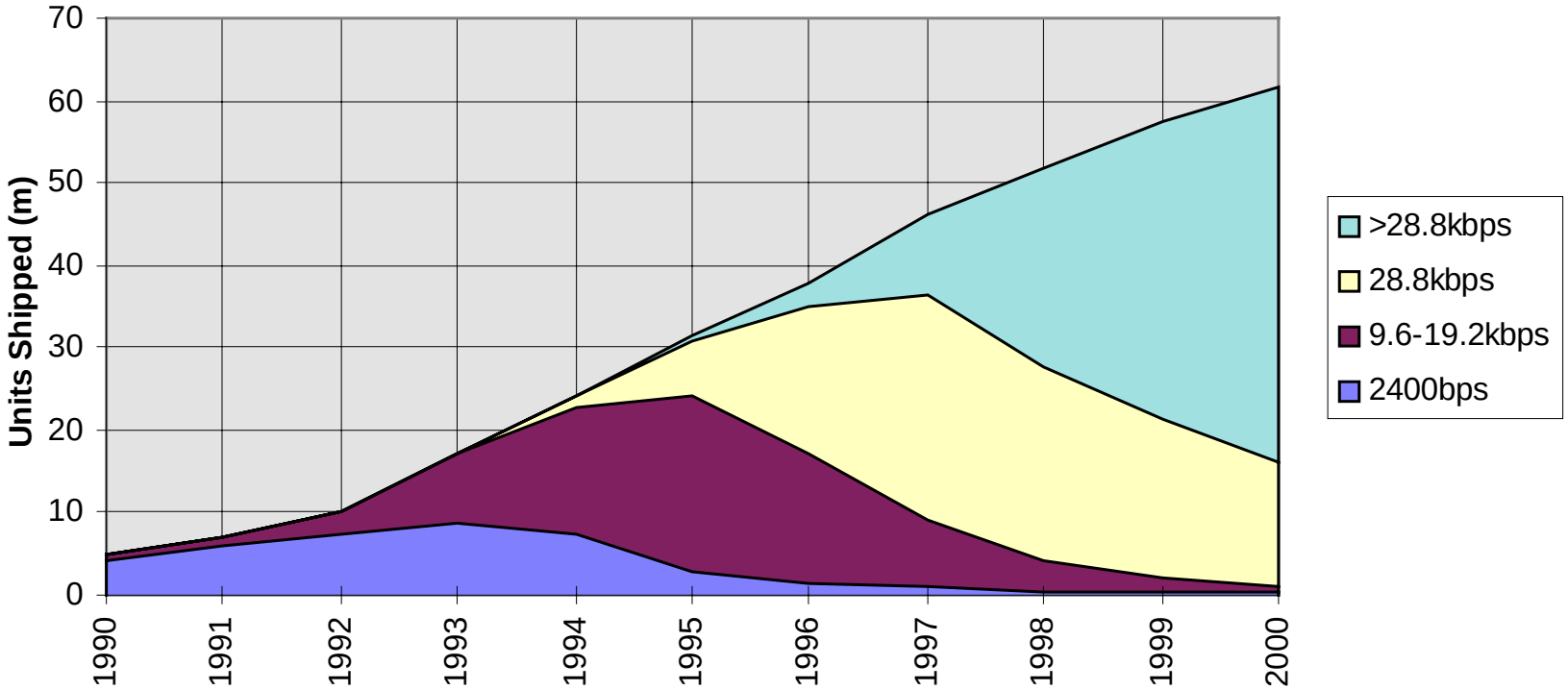
Source: AM, Probe Research (preliminary)

- Ethernet, ATM-SAR, CPUs, Memory, RF components
- 1-way modems add an analog modem

Other Technologies

- Intercast
  - Intel and co ...
  - data embedded within the VBI of NTSC/PAL video
  - supports existing infrastructure
    - » large near interactive down stream pipe
    - » telephone backchannel
    - » satellite
  - still requires Internet PoP account
  - convergence with MPEG-2 digital video service

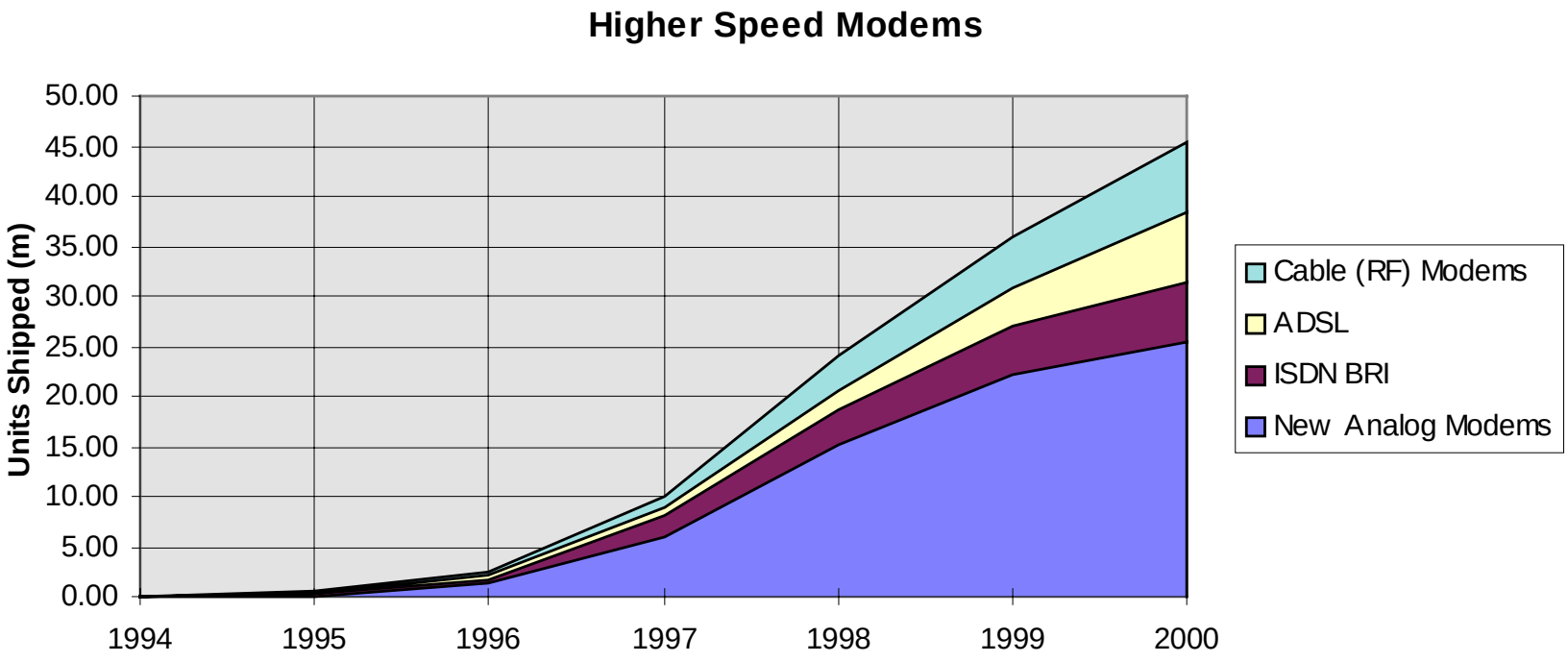
PC Modem Shipments/Trends



> 28.8kbps includes “higher speed analog modems, cable RF modems. digital alternatives, or a combination of all”

Source: Vision Quest 2000

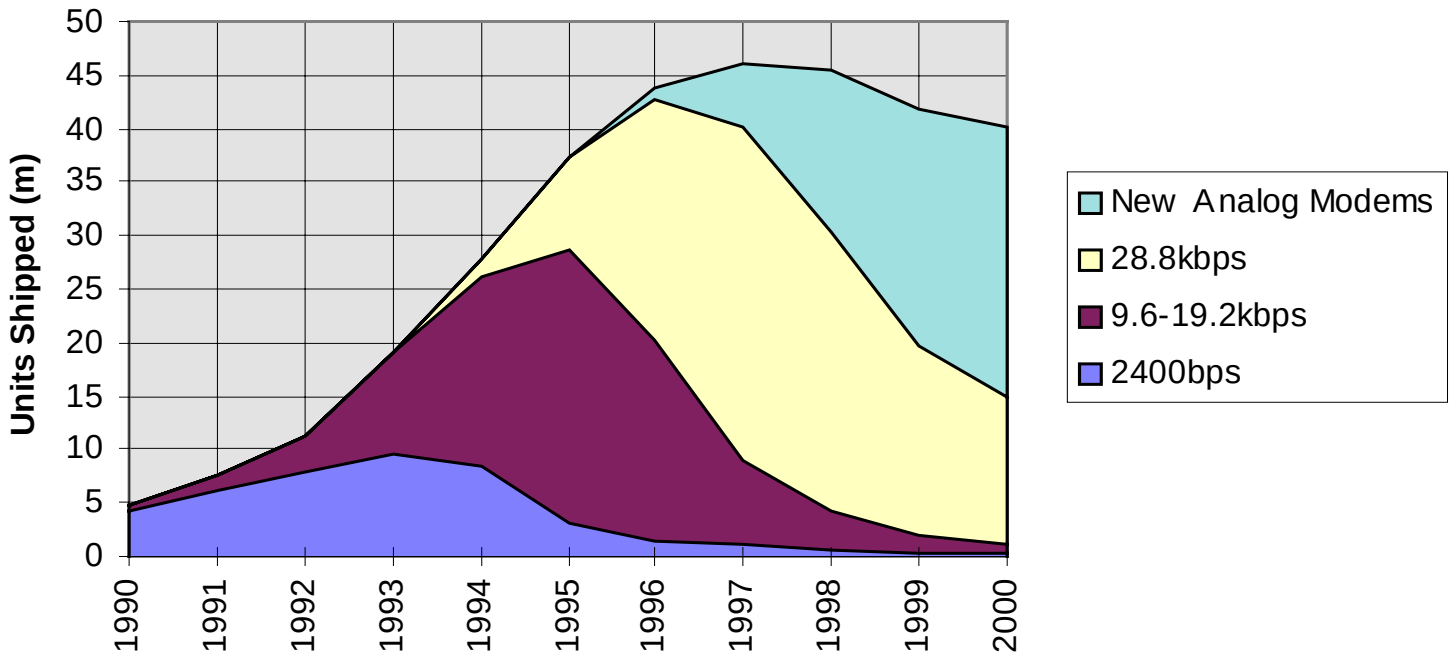
Other Modems Shipments/Trends



- Optimistic ADSL estimates from Forward Concepts
- Basic rate ISDN estimated from 2/3rds estimate of installed RBOC lines

Source: AMD-2 Strategic Mktg, Vision Quest 2000, Forward Concepts, Probe Research

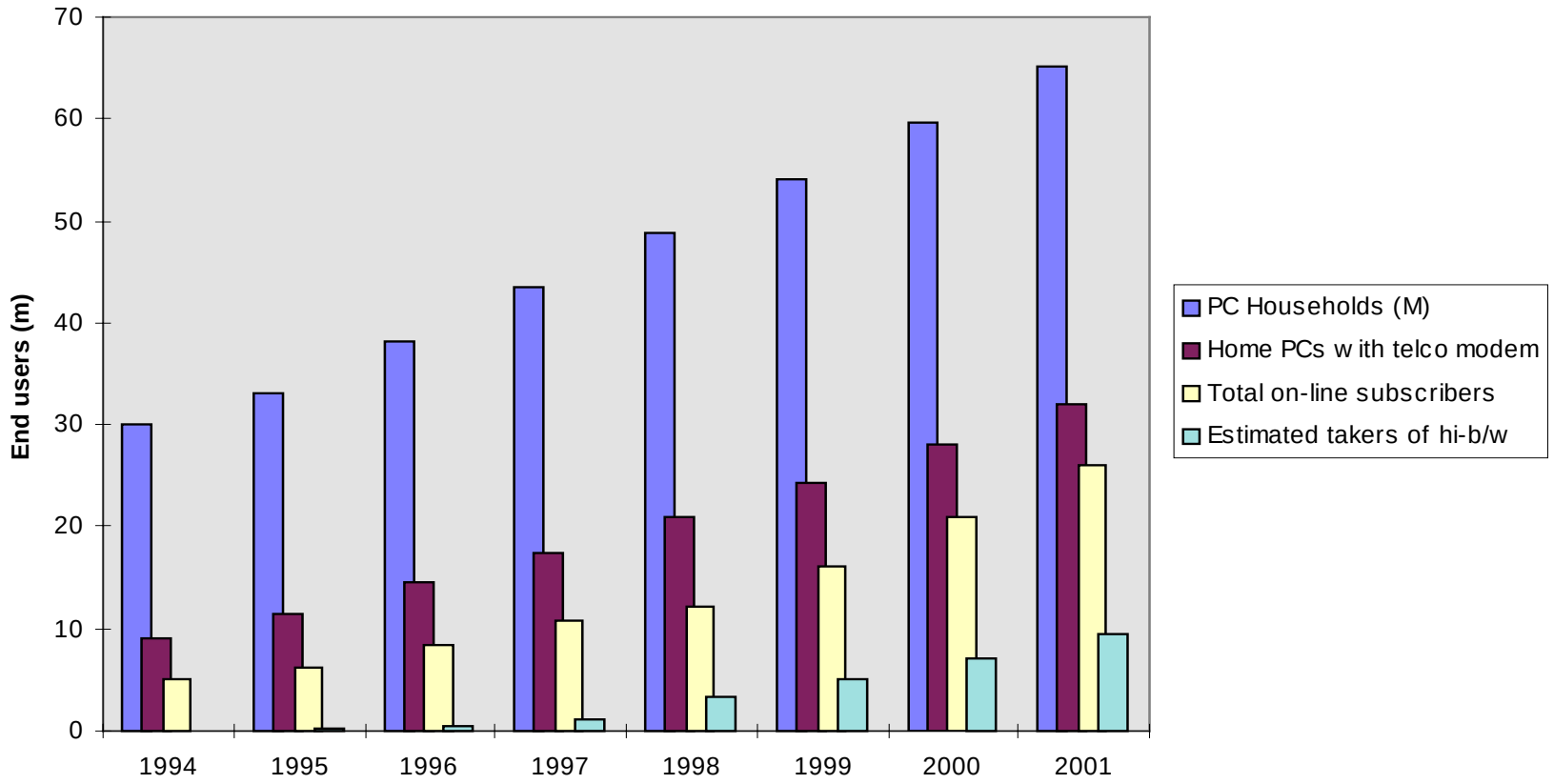
Analog Modem Shipments/Trends



Source: AMD-2 Strategic Mktg, Vision Quest 2000, Forward Concepts, Probe Research

- Removes estimates for higher bandwidth modems
- New analog includes V.34bis, DSVD plus feature enhanced analog modems

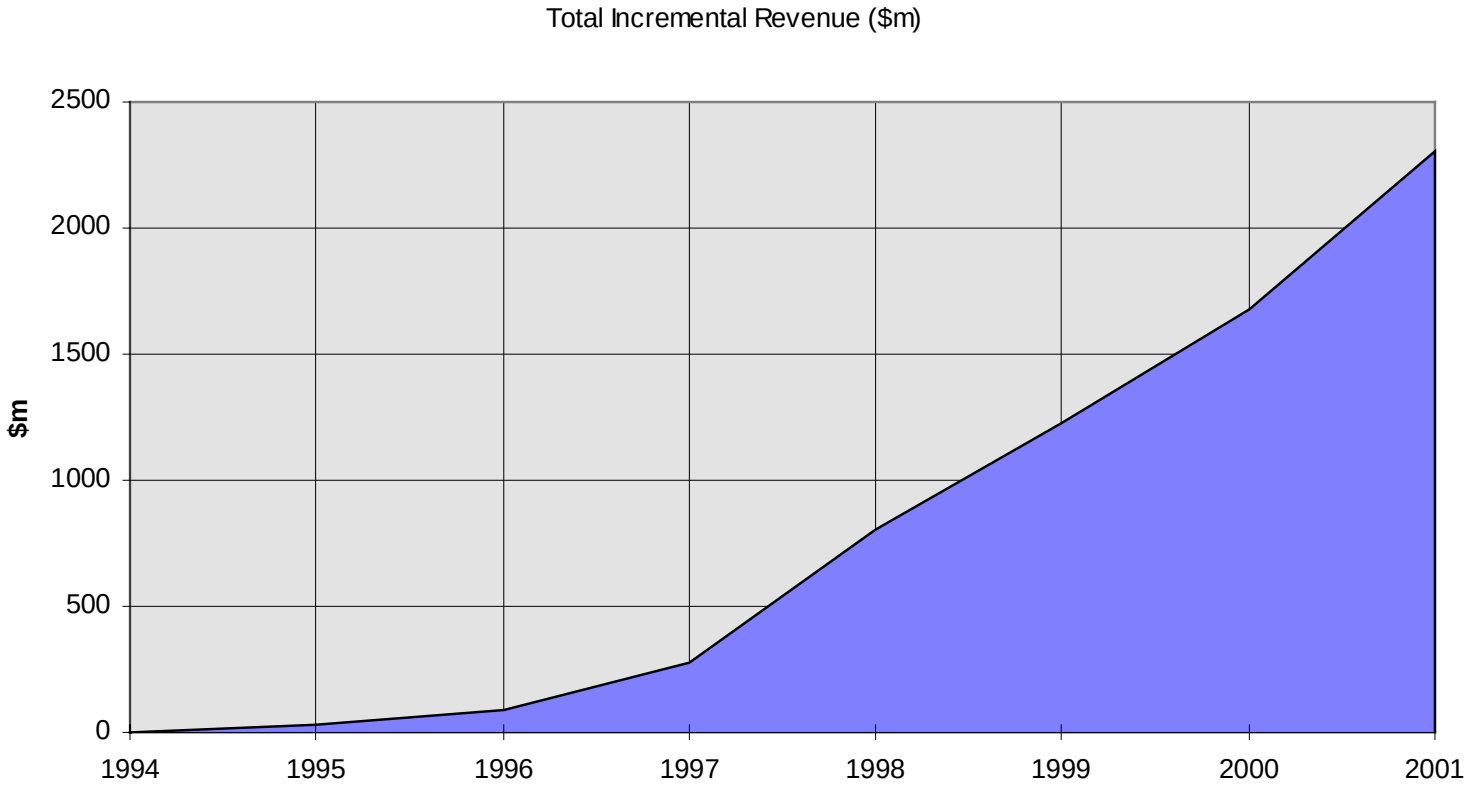
High Speed/Broadband On-line Market



Source: Probe Research, Nov '94

- Around 1.15m broadband access modems estimated by 1997, rising to 9.59m by 2001

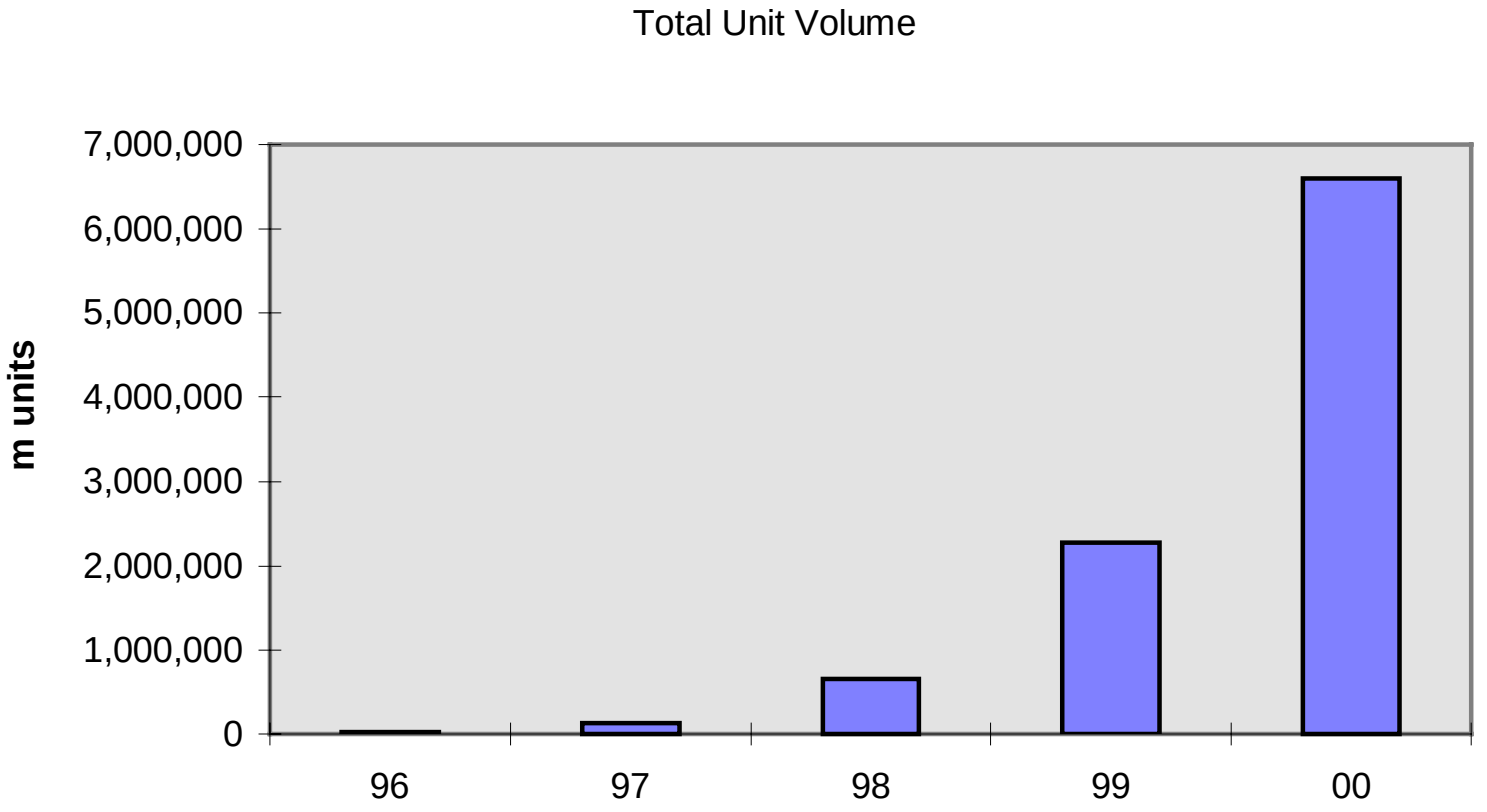
Incremental Revenue Potential for Broadband Providers



Source: Probe Research, Nov '94

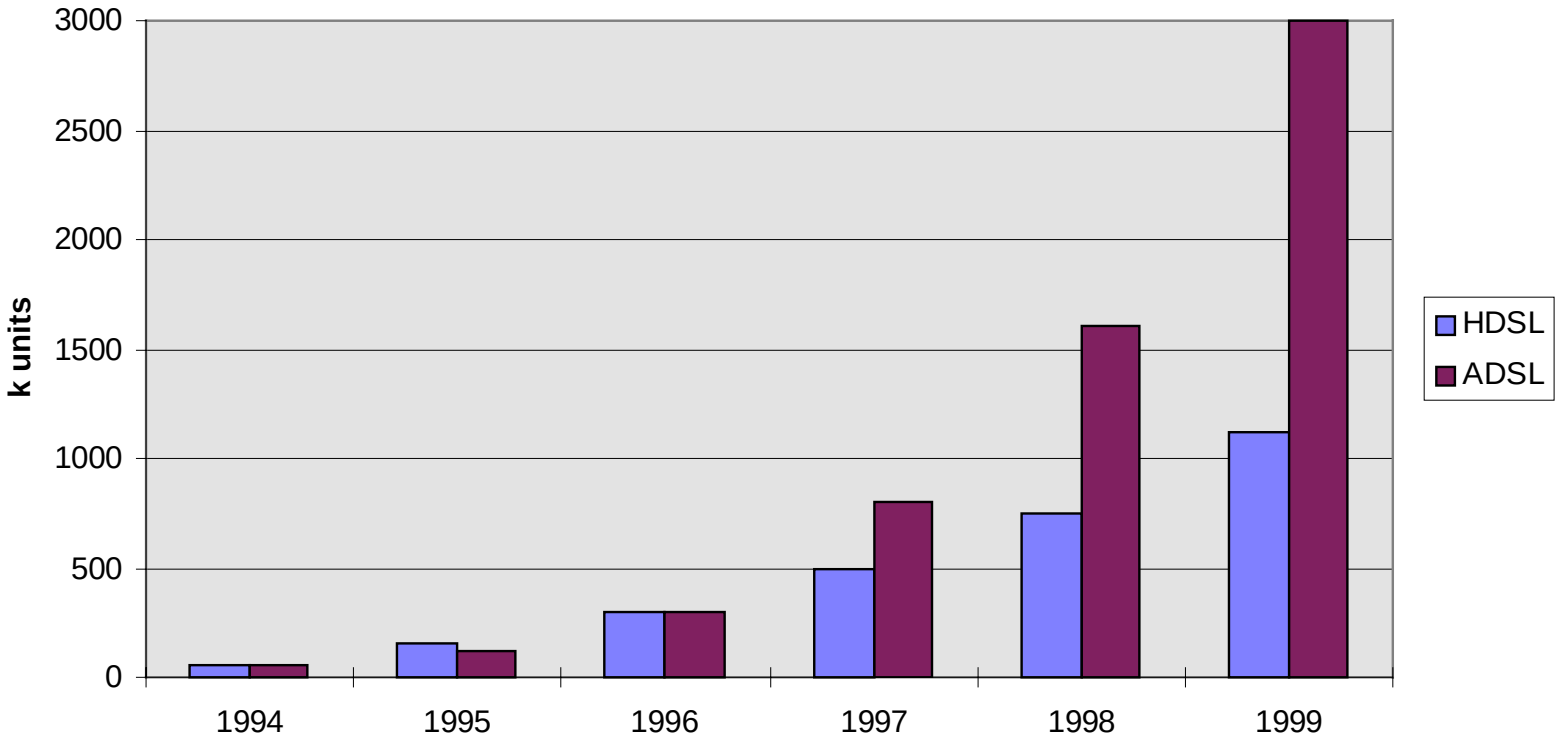
Note: Assumes a $20 average subscription to on-line service

Cable Modem IC Shipment Estimate



Source: AMD Customer

HDSL/ADSL IC Shipments



- Total ADSL IC revenues '99 $105m
- Total HDSL IC revenues '99 $51.7m

Source: Forward Concepts

Real Cost of Fiber

- Assume
  - 36 Fiber cables* at 2.4 Gbps per cable
  - Translates to 1.35 million 64 kbps channels
  - Fully outfitted with lasers, repeaters, power supplies, surveying, trenching and trucking
  - Cost - 40-60 Million Dollars

Real Cost of Fiber

- Assume technical life of circuit is 20-25 years
- This turns out to be 3-5 dollars per circuit per year
  - 60M$/1.35M channels/25 years = < $2 per year
- Providing the telcos with a profit margin, assume they could charge 10-20 dollars per year per circuit
- Actual cost ---- $15980* per year per 64kbps circuit
- At capacity, revenue 21.5 billion per year

* Stewart Fist 1996 -- www.abc.net.au/http/sfist/cablebw/htm

Real Cost of Fiber

- Sanity Check on the “real cost”
  - Using ITU numbers, there are 450 “dark fibers” in TAT cables.
  - Using a similar thought process, entire capacity generates $268 billion** per year
  - This revenue is greater than the combined sales of the top 10 communications equipment companies world wide

** Source: AMD, ITU